1 OCTOBER 1958

GAS IN INDUSTRY

Supplement to the "GAS JOURNAL"

Vol. 1 No. 6

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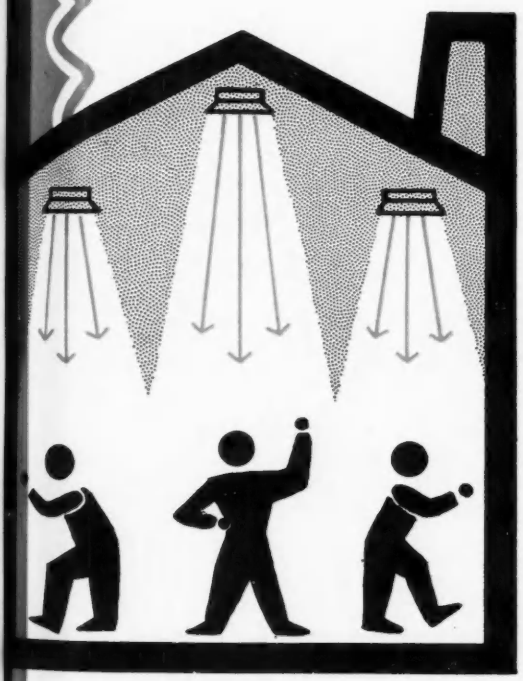

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GAS IN INDUSTRY

OCT. 1958

Vol. I No. 6

FEATURES

WORLD POWER CONFERENCE:

RECENT TRENDS IN THE INDUSTRIAL UTILISATION OF GAS AND A PATTERN OF FUTURE EXPANSION.—By S. G. Aberdein and A. E. Tyrell.

FUEL EFFICENCY EXHIBITION—A REVIEW OF SOME OF THE STANDS

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Editorial

Fuel Efficiency

THE Industrial Fuel Efficiency Exhibition opened at the National Hall at Olympia last week. This has now become a regular biennial feature and continues the series started in Manchester after the last war. The exhibition in October, 1956, was the first to be held in London and represented an advance by showing how increasingly important this aspect of the industrial scene has become and the need for its recognition by a wider public. The theme of the present exhibition is ' Greater Productivity at Lower Cost ' and a glance at the stands of the 170 exhibitors confirms how keen manufacturers are to show possible buyers how very real this ideal can be made. Although the National Hall is one of the smaller sections of Olympia, it is filled to capacity with all the latest appliances concerned with helping industry to cut its fuel costs. The provisions of the Clean Air Act make it imperative that not only should the most up-to-date fuel-using appliances be utilised, but also that pollution in any form of smoke or dust be completely suppressed. Smoke detecting indicators are to be seen on several stands together with grit arrestors and electro-precipitators.

The use of gas in industrial furnaces is clearly a means of fulfilling both requirements and the Gas Council stand takes the form of an advisory bureau at which anyone interested can consult technicians on duty on how best to convert his present appliances to the more easily controlled and flexible gas fuel. A large animated panel, which is a feature of this stand, shows how tank heating can be carried out more quickly and at a lower cost by a properly designed gas-operated furnace together with adequate insulation of all exposed surfaces to prevent unnecessary heat losses. Other panels show how gas can be effectively applied to the ceramics industry with an accompanying decrease in smoke and atmospheric pollution. Such furnaces facilitate mechanical handling and cut down costs both by more evenly controlled heating and a reduction in substandard products.

Other stands show how instrumentation is being continuously improved both in the accuracy of measurement by indicating and recording instruments, and in the neatness and ingenuity of design. Steam raising has now become an ' exact science ' and the need for continuous control of combustion conditions in the boiler firebox has made necessary the use of control consoles. From these the boiler house attendant can tell at a glance whether any change is taking place in the boilers under his charge. With the miniature indicators now available such a control unit can be confined to a small space and allow all information from a battery of boilers to be quickly and easily seen.

The use of gas in industrial furnaces makes necessary the proper provision of flame failure devices to ensure that, should the gas supply momentarily fail, full safety measures can be applied before reignition is allowed to take place when the supply is restored. Several firms showed such safety devices. In the past it has been difficult to combine thermostatic control with flame failure cut-off in the same unit. This has now been accomplished and successfully applied. Remote control ignition devices have also been designed for use with overhead heaters which have done away with the need for continuously burning by-passes, which can account for quite a large volume of gas over a long period.

Recent trends in the industrial utilisation of gas—

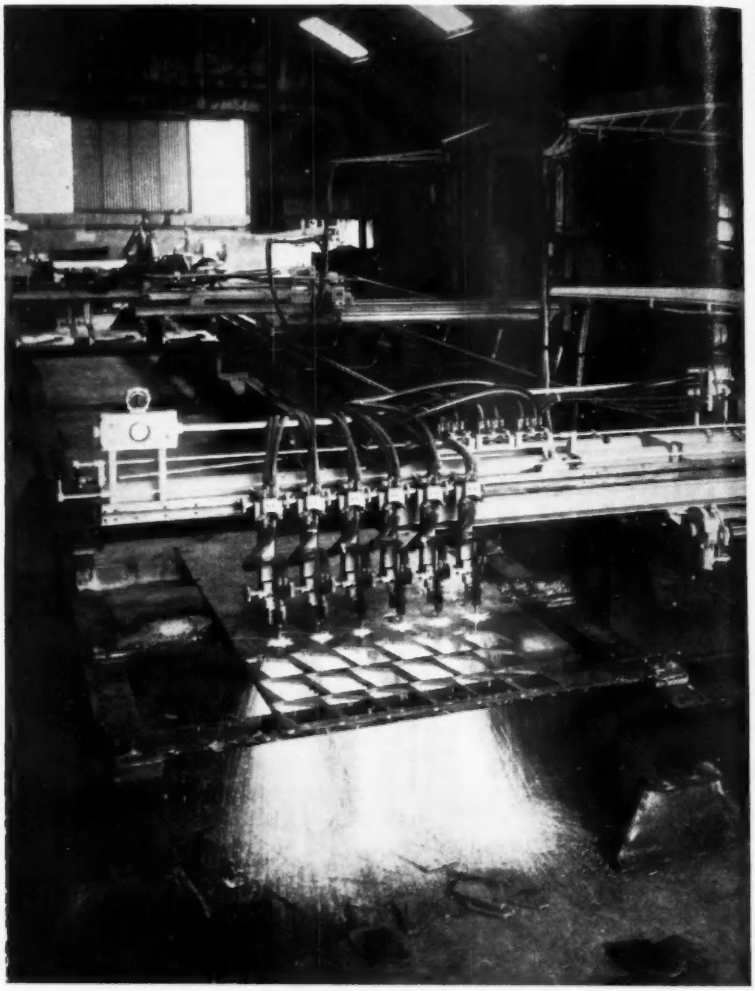

Fig. 1. An electronically controlled oxy-coal gas multi-burner cutting machine.

— AND A PATTERN OF PROBABLE FUTURE EXPANSION

RAISING the level of productivity is essential to a stable world economy. The effect of this varies considerably from nation to nation, and each has to study the problems involved in their own context. We in Britain are poor in raw materials but rich in talent, and industrial progress can be maintained only by the better use of available resources, both human and material. Technical innovation, however advantageous, must of necessity for us also be economically sound.

British industry is exceedingly varied; the variations in the size, methods and standards of firms, even within a single small trade, are often quite great. This makes more important, if more difficult, the identifying of obsolete practices; the study of industrial processes; the handling of materials; the layout of plant, and the conducting of technical surveys.

The availability of fuel is a most decisive factor in the development of industrial production in Great Britain and future requirements of fuel and power, and the extent to which they can be met, may influence both the rate and the type of production.

With the technical and economic advancement must be considered the problems connected with the disposal of manufactures in world markets. It is becoming an increasingly important feature of competitive marketing that goods shall be readily available, a factor of which all producers must take account.

The effect of these conditions can be seen in the changing pattern of British production and is mainly responsible for the increased rate of expansion of mechanisation and the rapid development of techniques of automatic control over manufacturing processes and their application to an ever widening range of industries.

It is vital to the needs of high quality and increased volumes of production that the adoption of automatic process and product control should continue, although the absence of suitable measuring units may limit the extent to which it can be applied in some industries. It is in the process industries, chemicals, iron and steel, cement, paper, printing and food that control techniques have found their principal application, and this field of application will extend wherever production can be organised as a continuous flow of material which responds under control to changes in the conditions of production.

These changes, which affect every branch of engineering science, are of particular significance to the heat engineer with their special problems

of time, temperature and space, and the urgent need to lower the ratio between the increase in national output and that of fuel consumption by constantly improving process efficiencies.

The course of British gas industry in the critical years ahead is clearly marked out. At present it provides 5% of industry's fuel needs in gaseous form and up to 5% more as coke and liquid fuels derived almost wholly from indigenous sources at production efficiencies which are continually rising and are now 77.8%. Utilisation efficiencies vary considerably from process to process, and much attention is paid by designers of gas equipment to the need for efficiency so that the advantage gained in higher production efficiency is not lost in plant of low efficiency.

Interlacing

The role of the gas industry in these changing industrial and economic conditions is to provide energy in the most suitable form, firstly by adapting its programme of research and development to meet the changes in industry and, secondly by co-operating more closely with industrial research organisations of other industries in their forward production planning. Much depends upon this interlacing of development work throughout industry, and it is interesting to examine some examples of technological progress that are the direct outcome of combined efforts of this kind, often involving a number of technical bodies.

About 10% of the town gas used in industry is required for flame applications of one kind or another, the cutting of metals, the manufacturing of electric lamps, radio valves, cathode ray tubes and in many similar ways, and the nature of the processing requires not only flexibility and a high degree of control, but also a high rate of output.

From this field of activity it is sufficient to take but one simple example of the progress towards full automatic processing. Flame cutting and profiling are now widely employed, principally because of the substantial reduction in machining time and the saving in labour. A single burner guided by hand around a template is now replaced by a gang of burners shown in Fig. 1. Six can be seen, although theoretically there is no limit to the number that can be used. These are electronically controlled by a tracer head, which, by means of a photo-electric cell, follows the contour of the most complicated drawings with complete accuracy. Controlled multiple cutting of this kind raises the production factor for the process to the highest practicable level, while keeping scrap and the need for labour at a minimum.

The direct application of heat by flames presents interesting prospects, for by this means considerable economies can be effected, not only in fuel but in labour, time and space.

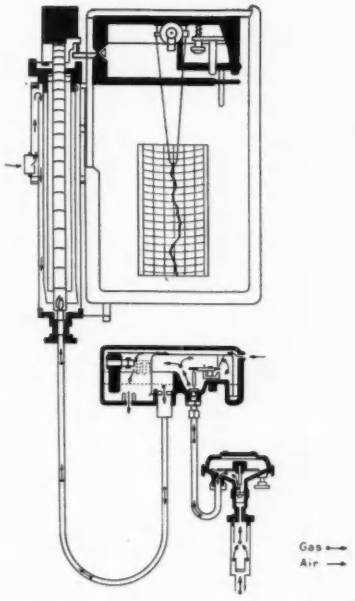

Fig. 2. Diagrammatic drawing of Wobbe Index recorder. The controlling unit can be incorporated or fitted remotely.

The development of high velocity jets has made possible higher flame speeds and greater useful heat release by the reduction of area of the cooling barrier. The advance of this technique into fields hitherto considered impracticable has, however, an associated involved problem of control. Constant calorific value is a statutory obligation, but constant composition and therefore constant specific gravity is impossible in conditions where the whole of the gas is manufactured, and is subject to wide variations in demand, often of an unpredictable nature, usually over short periods.

Such variations have considerable effect upon the combustion characteristics of a gas and it is necessary to have a scale or index that performs the function of describing the two widely differing qualities of calorific value and specific gravity in a single term. Thus the Wobbe Index was developed. It is a means of visually indicating flame characteristics of a particular gas and may be expressed by the simple formula

$$\frac{\text{Calorific Value}}{\sqrt{\text{Specific Gravity}}}$$

Automatic control of this condition is vital in the field of flame application, and as a result an instrument has been developed which will maintain the Wobbe Index of an air/gas mixture within 1% of a chosen value, independent of the composition of the incoming gas.

Fine Limits

Gas is fed to a precision governor which maintains the pressure constant within very fine limits (see Fig. 2). The gas burns at the base of a metal cylinder which expands, this movement being made to actuate a pen. For control purposes the pen operates a pneumatic controller, which in turn varies the proportioning device on the air/gas mixer.

Fig. 3 is a line diagram showing the method of incorporating the controller into an installation, in this case the precise control of a hydrogen-nitrogen gas producer. The control of this

by

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and

A. E. TYRELL,

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World Power Conference, Montreal, September 7-11

condition marks an important step forward in the extension of the use of principles which will have a considerable effect upon the efficient use of gas.

Another and quite different example of the adaptability of gas to continuous processing is to be found in the treatment of glass to render it safe if shattered. The styling of automobiles during the past two years has involved the more extensive use of glass.

Panoramic wind-shields and back lights have added several square feet of glass to each car, and with the output of vehicles at its present level, the total quantity of safety glass required for the motor car industry alone has risen to over 20 mill. sq. ft. per annum. In addition to greater demand, more intricate shapes and closer dimensional accuracy have presented technical problems of some complexity.

For the production of safety glass, high quality sheet or plate glass is used—the latter is always used for wind-shields. The safety factor is introduced by the thermal surface stressing of the glass. This is brought about by heating the glass through zones of varying temperatures from 450°C. to 750°C., when it is withdrawn from the furnace, pressed to shape, when vertical bending is employed, and then cooled rapidly by high pressure air to about 350°C.

Gravity

Vertical bending is suitable for all simple glass shapes, but the more intricate patterns are dealt with by gravity bending. In this case the flat sheet of glass is laid on a mould which is then passed through a furnace with zones at different temperatures which can be varied to suit the shape, size and weight of glass. As the glass softens, it falls by gravity and takes the shape of the mould, an extra boost of heat being given in the final stages to ensure that the sharp contours at each end assume the shape of the mould accurately.

With either vertical or gravity bending the furnaces are heated by gas-fired radiant tubes which gives the flexibility required to deal with the diversity of shapes and sizes of glass. Cooling is vital, for upon this depends uniform stressing.

British standards require that, if shattered, the glass shall show a fragmentation pattern of not less than 80 pieces per 4 sq. in. In practice most toughened safety glass assumes a pattern of the order of 150 to 160 pieces per 4 sq. in.

Fig. 4 is a photograph of an electronically controlled vertical bending plant dealing with glass pieces requiring a time cycle of 5 minutes. Fig. 5 is a line diagram of the plant describing the movement of the glass through the plant. Fig. 6 is a diagrammatic drawing of a gravity bending plant, the glass and mould being supported and taken through the furnace on suitable carriages. The time cycle in this case is about 28 minutes.

Increased production is possible only if automatic means of processing are applied at every stage for each component, and few industries have been faced with greater difficulties in this connection than the iron and steel industry. As a primary industry, it is the biggest user of fuel in Britain and has therefore much to gain by even the smallest increase in efficiency. To provide iron and steel in the many forms in which it is required means the employment of a great variety of plant in widely differing processes. About half a million tons of steel strip is produced in Britain annually. Annealing is one of the necessary steps in its production, its function being to restore by heat treatment the ductility of the steel which has been diminished or lost in the cold reduction process. Annealing the strip in batches in removable cover furnaces involving a long time cycle has been customary for some time.

In continuous annealing, which will gradually replace batch methods when the tonnage to be treated warrants it, the cold reduced steel strip enters the furnace section, makes a series of loops, passes through a cooling zone and is then rewound. The temperature of the furnace is 730°C., and is sufficient to remove the cold working strain set up in rolling.

The principal advantage of the process is the speed with which it can be completed, five minutes as opposed to five to seven days for the batch method, with a corresponding reduction in handling, factory space and fuel.

Fig. 7 is a photograph of a continuous plant capable of treating 16½ tons of strip an hour, or 2,500 tons in a 152 hour week. It is the largest plant of its kind in Europe. In the heating section the strip is surrounded by an inert atmosphere, the heating being by specially designed gas-heated radiant tubes, the required temperatures being automatically maintained. A short soaking period follows, after which the strip is cooled in a protective atmosphere to below the temperature

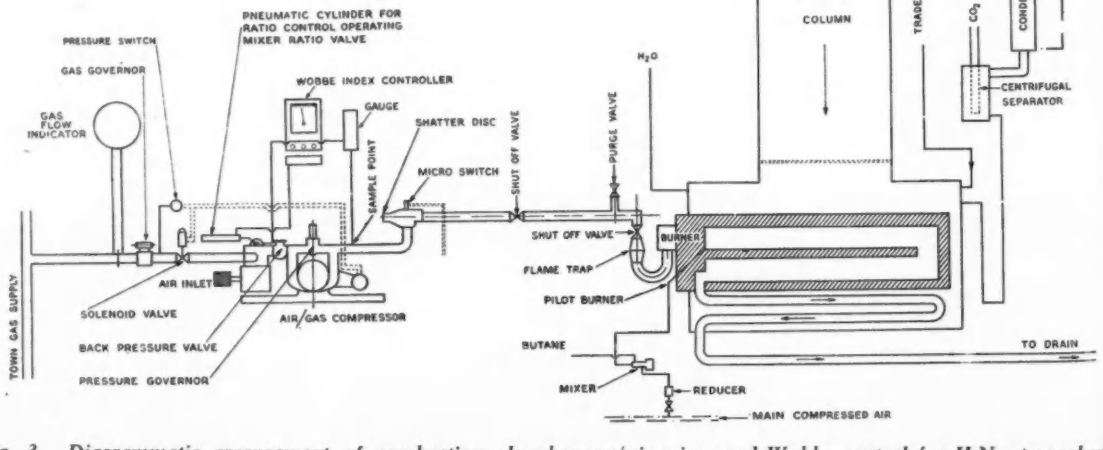


Fig. 3. Diagrammatic arrangement of combustion chamber gas/air mixer and Wobbe control for H.N. atmosphere gas plant (part drawing only).

at which oxidation can take place, and the strip is then rewound. To remove oil or lubricant collected during rolling, the annealing process is preceded by automatic degreasing and cleaning.

The use of an increasing range of metals and their alloys, and the need to meet high quality standards with greater speed in production, has focused more attention on the heat treatment processes.

Many heat treatment furnaces are so constructed that it is difficult to prevent the admission of air into the working chamber. A certain degree of control over their condition in some fuel burning furnaces can be exercised by control of the air/fuel mixture, but generally this is inadequate to eliminate the undesirable surface changes in the materials being treated.

A further change, metallurgical in character, is brought about when treating steel by the addition or removal of carbon from the surface of the metal.

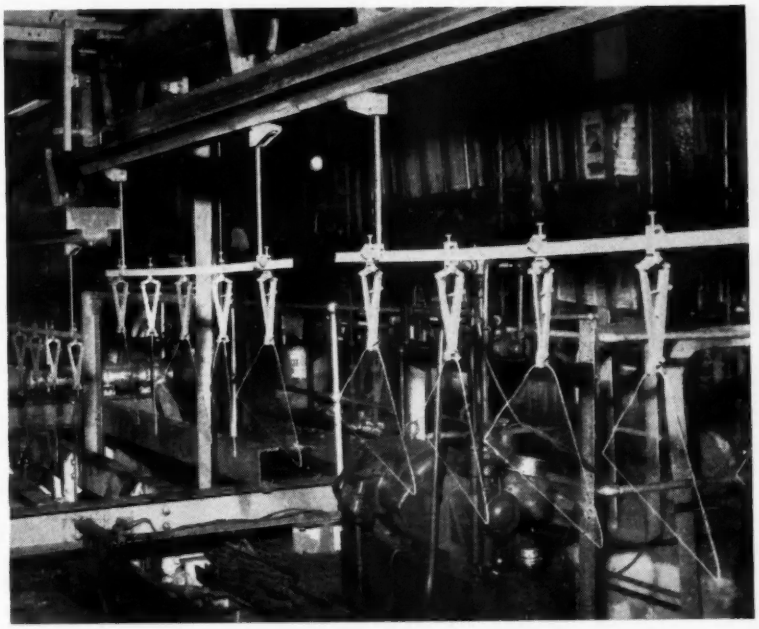


Fig. 4. Vertical glass bending process. Glass entering furnace

Vital

With thermal and mechanical stressing tending to become higher, particularly in aero engine design, the development of higher quality materials with more complex treatment and the necessity to eliminate or reduce cleaning and correcting operations following heat treatment, accurate control of the causes that give rise to these conditions is vital. This has meant important changes in furnace construction with gas tight steel casings, tight mechanically operated doors, and the use of loading and unloading chambers.

A protective atmosphere in the furnace is provided from an external source through an independent generator, the atmosphere gases or, more commonly, combinations of gases are used to displace, or augment, the air in the working space and the loading and unloading chambers.

In most gas furnaces the atmosphere gas is isolated from the heat source by the introduction of radiant tubes in which the heating gas burns. These tubes are of various shapes and sizes, are manufactured from nickel-chrome alloys, either spun cast or light drawn, and are suitable for temperatures up to 950°C. The successful use of radiant tubes at high temperature is one of the most significant changes in furnace design in recent times, and has made possible a most desirable trend towards fully automatic atmosphere controlled heat treatment practices in many industries.

The atmosphere generators are generally of two types, exothermic and endothermic, the former producing a gas with the widest application. Any of the hydrocarbon gases, such as town gas, coke oven gas, natural gas, propane and butane, are most commonly used.

The endothermic generator employs a heated catalyst of refractory material impregnated with nickel salts and a mixture of gas and air are passed over it, the time, temperature and gas/air ratio being adjusted to promote a breakdown of hydrocarbons without

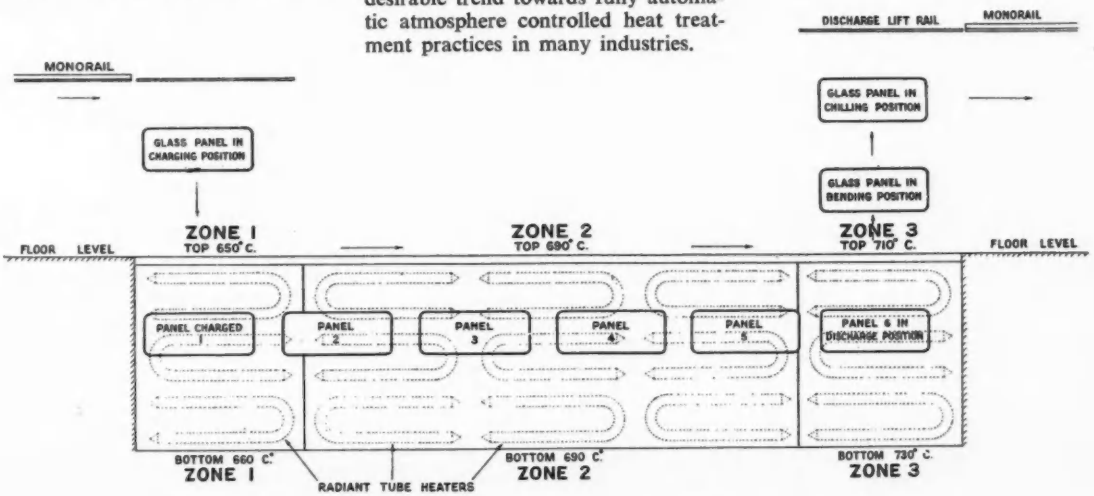
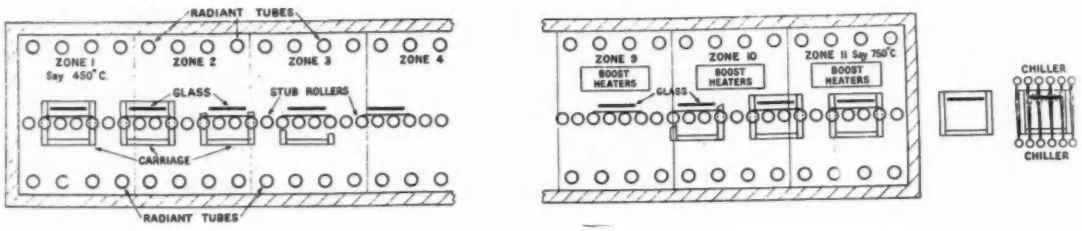


Fig. 5. Diagrammatic drawing of continuous furnace for vertical glass bending process.



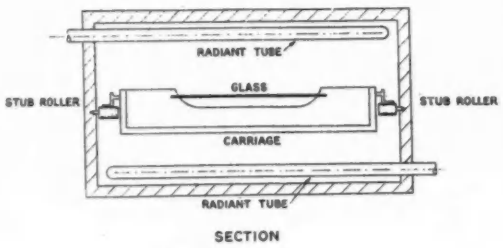


Fig 6. Diagrammatic drawing of continuous furnace for bending glass by the gravity drop process.

the simultaneous occurrence of the usual combustion reactions. The control of the carburising-decarburising tendency is extremely important in the thermal treatment of ferrous metals.

Application of controlled atmospheres for bright annealing and normalising, and for the treatment of many non-ferrous metals, has made rapid headway, but progress has been less marked in dealing with medium and high carbon steels, particularly in the smaller batch furnaces. This has been due to difficulties of design, costs of the plant, and lack of control of non-decarburising atmospheres.

Notwithstanding these difficulties, technical problems have been solved and Fig. 8 shows a cut away sectional photograph of a plant capable of dealing with 250 lb. of work per hour, the atmosphere generator of endothermic type, using either town gas or propane, being fitted on the right of the furnace.

The heating is by means of recuperative gas heated radiant tubes arranged horizontally, and working under suction. A circulating fan in nickel-chrome under the furnace arch ensures uniform and rapid heating of the charge. The furnace has a sealed quench inside a water cooled gas tight vestibule, the charge being lowered into the oil quench bath by a double deck lift enabling a further batch of work to be loaded into the furnace while the withdrawn load is being quenched out. All furnace doors and lifts are power operated, and a gas curtain ignites automatically when the

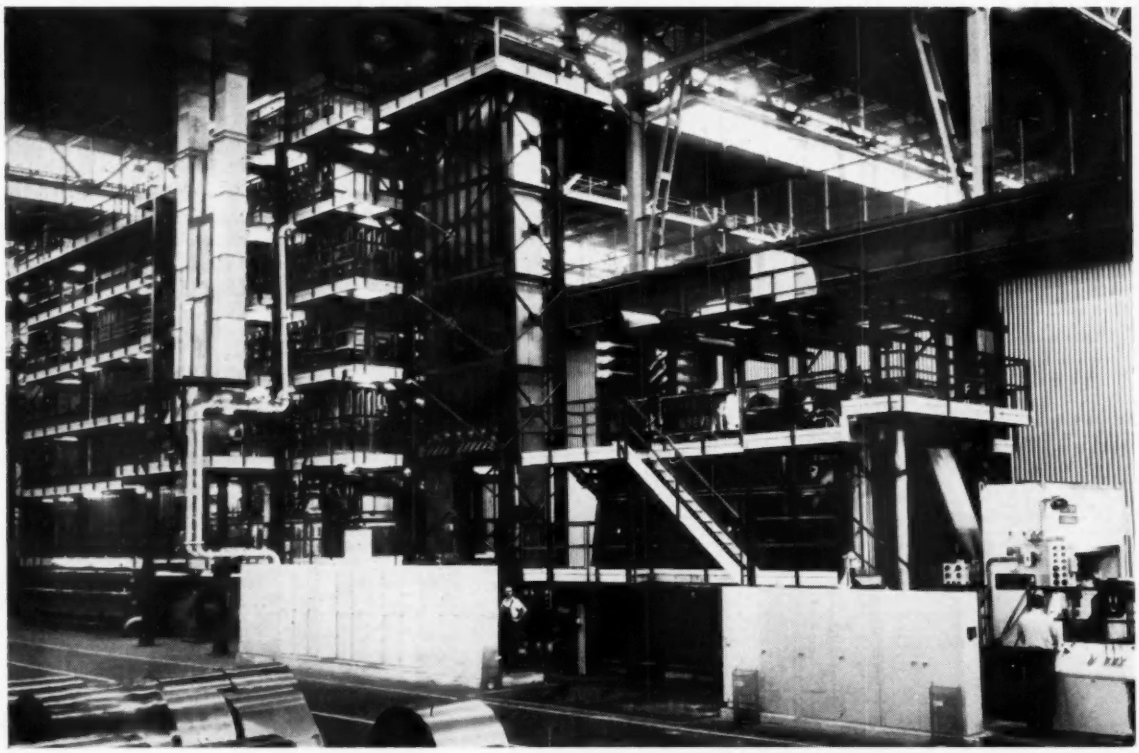


Fig. 7. A continuous steel strip annealing plant capable of treating 16½ tons per hour. Entry end.

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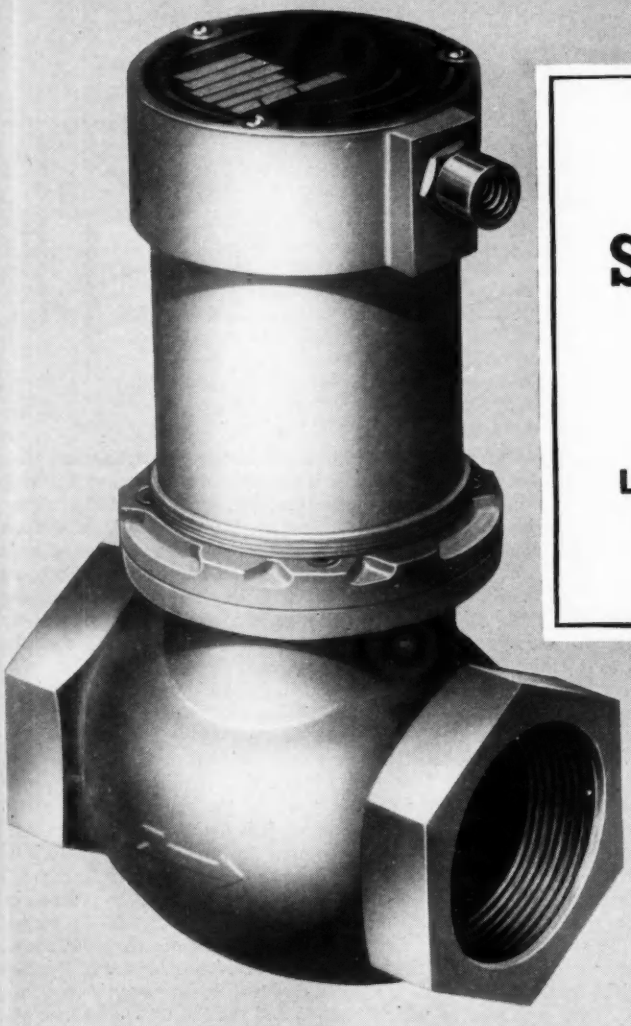

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outer door is raised, thus preventing the ingress of air.

The underlying principle in the development of plant for clean and bright heat treatment is the efficient application of a suitable controlled atmosphere. The atmosphere must be in equilibrium with the metal being treated over the range of temperature employed. It is not sufficient merely to protect the metal from oxidation.

The study of the physico-chemical aspects of controlled atmosphere practice has brought a better understanding of inter-gas and gas-metal equilibria and the wider application of this knowledge to industrial heat processes is of technical significance.

While the trend for producing furnace atmospheres has been towards independent generators, for by this means control over the composition of the atmosphere over wide limits is possible, some very important work has been going on in connection with the control of atmospheres in direct operated furnaces. This work is based on the conclusion, that a system of control by automatic means of the combustion of the fuel in a condition less than the stoichiometric proportions of air, results in a furnace atmosphere that is highly reducing. This has been accompanied by very much higher efficiencies at elevated temperatures, mostly in the region 1,300°C.

The heating cycle is regenerative with automatic flow reversal by special pulsators in which the combustion air is preheated to a high level, completion of combustion being brought about by introducing secondary air into the flue gases.

Restricts

Using the fuel combustion gases as a means of providing protective atmospheres restricts the application of this new technique to such processes as forging and reheating because of the possible decarburising of the metal. The speed of heating, about 17 minutes to reach temperatures of 1,000°C. is sufficiently short to prevent any change taking place in the boundary layers of the treated metal.

The advantages to be gained from this development are very much lower heat requirements, of the order of 1,000 B.t.u. per pound of metal treated at 1,200°C., increased speed and the elimination of metal loss in the furnace, which, in furnaces of conventional design, may be as high as 4 or 5%. The system can be applied to existing or new furnaces, whether of the batch or continuous type.

Improvements in process costs and efficiency, often exceeding 30%, have been obtained in practice.

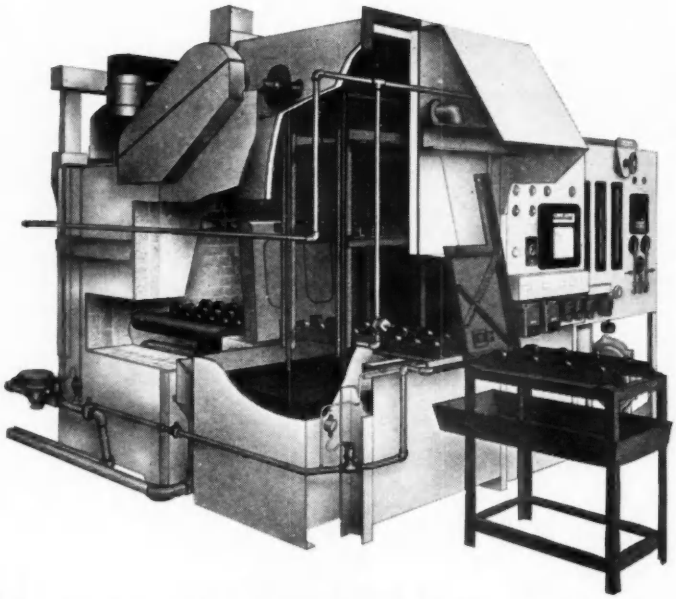


Fig. 8. Cut away section of a gas heated batch type clean heat treatment furnace with sealed quench. Temperatures up to 1,000°C.

The industrial application of prepared atmospheres becomes more involved when other controllable variables are introduced in order to bring about specific metallurgical changes in the metal.

For maximum wearing qualities, steel surfaces must be suitable for heat treating to give surface hardness. The means to do this are collectively known as case hardening processes, by which a steel component is produced with a hard wear resistant surface overlying a ductile, shock-resistant core.

These processes fall broadly into two categories.

First, those in which the chemical composition of the surface layers is altered with respect to one or more elements, the resulting differences in properties between case and core being further developed, if necessary, by appropriate heat treatment.

Secondly, those processes in which no surface chemical changes are brought about, but the essential contrast in properties is achieved by preferential heating of the surface layers followed by quenching.

Carburising, in which a steel component of relatively low carbon content is given a high carbon case, is the most widely practised of the case-hardening processes. The necessary carbon may be imparted by immersion in either a solid, liquid or gaseous carburising medium. Of these three alternatives the gas carburising method is becoming the most important. The reasons for this are the economic and technical advantages that continuous gas carburising, which is developing from the batch process, has to offer.

The savings in fuel, labour and materials are high, while the reduction in floor space for a given throughput, as compared with the pack process, may exceed 50%. In addition, full process control permits of the plant being sited in the production shop, reducing considerably the handling of materials, while direct quenching from the furnace often eliminates one of the conventional reheating operations.

While the chemistry of the process is new in the thermal treatment of metals, it is the engineering techniques required to provide and maintain the necessary conditions for the gas to metal surface reactions to proceed in a predictable manner, and to embody suitable methods of automatic control, that have limited progress in this field.

Considerable headway is now being made and the largest continuous plant of its kind in Europe, capable on completion of treating over a ton of transmission gears an hour, is nearing completion. In the layout shown in Fig. 9 three of the units can be seen, it having been possible to maintain flow direction and volume by the adoption of continuous methods of treatment. Furnace No. 1 has two tracks operating independently to deal with stock requiring varying case depths, the whole operation including quenching, washing and tempering being entirely automatic and controlled by one operator.

The furnace conditions are as follows:—

	Zone 1 Charge	Zone 2	Zone 3	Zone 4	Discharge
Temperature	940°C	940°C	940°C	840°C	
Generator gas	450 cu. ft. per hour	450	450	450	
Enrichment gas—propane	3 cu. ft. per hour	6·5	Nil	Nil	

Generator Gas	Gas Analysis				Dewpoint
	CO_2	CO	N_2	CH_4	
Propane/air 1-8 Retort temperature 1040°C.	0·3% max.	22·6-30%	29·5-30%	Nil	32-35°F.
Furnace atmosphere	0·3% max.	22.8-23%	29·5-30%	0·5-0·7%	24-28°F.

Time in furnace, including quench cooling = 17 hours.
Case depth ·055 in.-·060 in. *Carbon content of Case* ·80–·85%.
Fuel used 4·7 cu. ft. of 500 c.v. gas per lb. of metal treated.
Heating is by means of horizontal gas heated radiant tubes.

All the temperature controls are automatic, each zone being controlled separately. In addition, an overriding visual recorder is employed as a safety measure against overheating in any zone. Dewpoints are checked frequently and experiments are being carried out with an automatic controller.

Each furnace has its own endothermic gas generator capable of dealing with 2,000 cu.ft. per hour, the reaction in the retort being—

$C_3H_8 + 1\frac{1}{2}O_2 + 6N_2 \quad 3CO + 4H_2 + 6N_2$

thus one volume of propane yields 13 volumes of gas with the analysis:— 23% CO 31% H_2 46% N. Dewpoint 10°F. to 20°F.

The equation allows for a ratio of one volume of propane to seven and a half volumes of air, although in actual practice a slightly weaker mixture nearer 1 to 8, giving a dewpoint 30/35°F. is used. Without the introduction of this continuous process, the required production levels could not have been reached, and it is estimated that up to 50% in time, space, labour and fuel have been saved.

Adjustable

Fig. 10 is an example of integrated continuous processing, particularly suited to small components. The progress through the carburising furnace is adjustable to allow for any depth of case. Rotation of the retort is alternatively clockwise and anti-clockwise, the motions being timed by means of an electrical timer. The total time in the carburising furnace is 7½ hours to produce a case depth of .040-.045 in. (to .4%C.)

All evidence now points to continuous gas carburising becoming established practice. Of the many factors that have had to be considered, none were more important than the control of the temperature and reaction conditions and the uniform distribution of the carburising gas through the work. With these difficulties overcome, progress towards even bigger units will be more rapid.

In the second category of the case hardening processes the most important advances have been made in the field of flame hardening. In this process heat is applied to a limited surface area, such as the teeth of gear wheels, the contact surfaces of crankshafts, or to components in which the area to be treated is small in relation to the size of the component.

Carbon steels with carbon .3-.6%, carbon manganese and nickel-chrome steels, preferably containing molybdenum, are most suitable for flame hardening, but plain carbon steels and some low alloy steels can be successfully surface hardened by flame heating methods.

There are a number of flame hardening machines, some fully automatic. They can be adapted to suit any class of work, the flame and coolant being made to traverse the shape of the component, or if preferred the work can be passed through stationary flames and coolant. Oxygen is used in conjunction with the town gas, and high speeds of heating are obtained, which, with controlled cooling, ensures great accuracy of case depth. The process is particularly suitable for incorporating into high rate or mass production lines.

Few industries in Britain have undergone such revolutionary changes in its method of production as the ceramic industry, in which the thermal component of production costs is high. Most of the traditional handcraft processes have given place to mechanisation, and some to fully automatic means of processing.

The coal-fired bottle kiln, on which the industry was largely founded, rarely had efficiencies exceeding 3%, required great skill in handling and, despite it, firing faults were as high as 15%. The advent of the continuous gas-fired kiln improved this situation beyond recognition. It paved the way to continuous production, introduced means hitherto thought impracticable to control automatically many processes, reduced faulty work to less than 1% and, at the same time, cut fuel consumptions to a coal equivalent less than one-third of that needed for the bottle kiln. As a result the demand for gas increased from 568 mill. cu.ft. per annum used on 30 kilns in 1937 to 7,074 mill. cu.ft. on 288 kilns in 1957.

Recent improvements to the continous tunnel kiln have still further increased its efficiency and thereby extended its use, and at the same time research has been directed towards the development of a kiln having design features quite different to those of the tunnel kiln.

The multi-passage kiln has resulted from this work, and Fig. 11 is a part drawing of the kiln. It is 40 ft. long with a width of 6 ft. 6 in. and a height of 6 ft. It is divided into three zones, the preheating zone being approximately 16 ft. long, (the heating zone approximately 11 ft. 6 in. long and the cooling zone 12 ft. 6 in. There are four work passages, each measuring 15 in. wide by 7½ in. high, these being heated by means of burners positioned in combustion passages above and below.

Tests over a long period indicate that the saving of about one half of the heat input per ton of load treated, as compared with one ton of load treated in the open-fired continuous tunnel kiln, are probable in practice.

With the abolition of coal firing the dense smoke pall inherent with the locality of the Potteries has disappeared.

Food Preparation

The advantages to the large catering organisations of preparing food in central kitchens, as opposed to a number of dispersed kitchens are made more evident by shortages of skilled staff.

To cook large volumes of food suitable for providing a high standard restaurant service has required the development of continuously operating plant of unusual design.

Fig. 12 shows a shallow fat fryer for cooking one and half cwts. of sausages or escalope of veal per hour. The heating is by means of bar type gas heated low pressure burners, individually operated to give control over a wide range of the cooking area.

The average consumption is approximately .5 therms per cwt. of

meat cooked and one operator can deal with this output.

Many foods, particularly the more amorphous, lend themselves to continuous automatic methods of production, and in Fig. 13 can be seen a continuous automatic plant for the braising of meats and preparation of soups and vegetables. The plant is 40 ft. long, has a capacity of 36 containers and can prepare up to two tons of food of various kinds per hour.

Heat is applied direct to the containers by multi-jet type burners, control being in sections by a single lever operating in conjunction with a pressure gauge.

The containers move through the unit on a conveyor, the speed of which can be varied to suit the product. The mixed nature of the foods being dealt with, often simultaneously, makes thermal input difficult to compute accurately, but the maximum would not exceed an average of 1 therm per cwt., of mixed food.

This output is handled on average by four operators.

All such cooked food is frozen while hot and is then distributed. In this way high standards of hygiene and safety are maintained.

To provide large numbers of meals daily, cooked at many retail centres would involve labour and fuel costs, at least three times greater than when prepared centrally, even after taking into account the cost for freezing centrally and reheating the food locally at retail catering establishments.

Future Development

During the past few years, the fuel component of production costs has

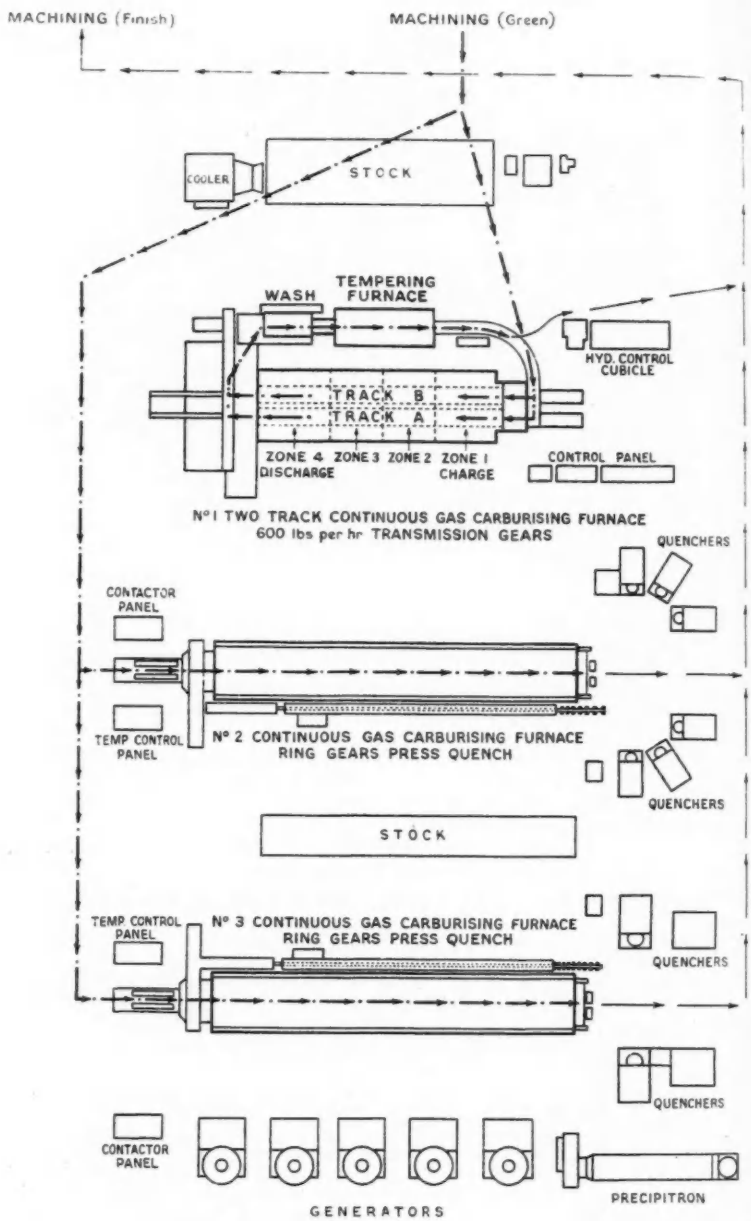
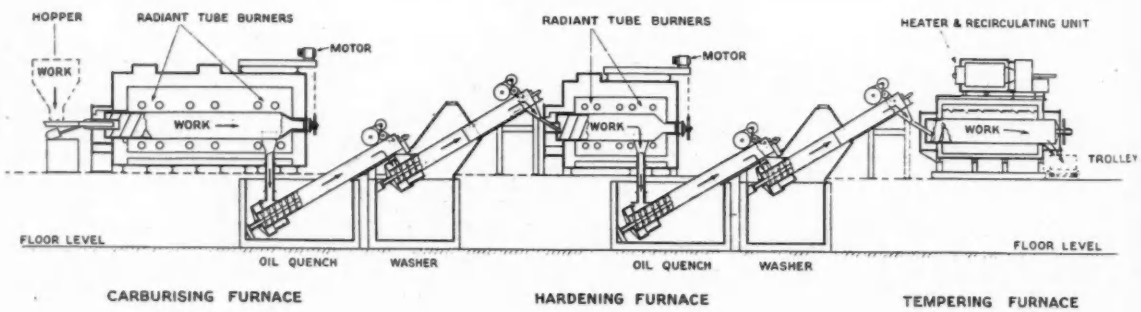


Fig. 9. **(Right)** *Layout of continuous gas carburising units for treatment of gears.*

Fig. 10. **(Below)** *Rotating retort type integrated gas carburising hardening and tempering plant for continuous processing of small parts.*



SECTIONAL ELEVATION

tended to rise beyond the 3% average for industry at which it has stood for some time, mainly because the problem of greater volumes of production with increased speed has found solution, in part at least, by increased heat processing. This has brought an increase in the use of gas in industry, which is expected to continue.

The commercial uses also continue to increase, while the domestic demand tends to decline. An important factor in such a changing pattern of demand is the effect on the tariff structure owing to the relatively high average yield of the domestic load by comparison with the industrial and commercial loads.

Influencing

Forecasts of fuel demand have not run true to prediction because account could not possibly be taken of the many influencing factors so far in advance. It is clear that fuel and power requirements cannot be met from coal alone, although it must remain the chief source of energy for many years to come, and the difference between what is needed and that provided by coal from indigenous sources must be made up at present by imports of coal and oil, and ultimately by nuclear power.

These factors combined with the economic changes in the coal industry have created a situation in which more attention has of necessity been paid, not only to rate of improvement in the production and utilisation efficiencies, but to the possibility of using other sources of materials for gas making.

The British gas industry has based its future planning on extending the use of gas and coke for all purposes, not only to implement the campaigns against atmospheric pollution, but to make the most efficient use of available fuel supplies by an investment programme involving additional gas plant, much of it of quite new design.

Conventional

For the time being the industry must depend mainly upon carbonising plant of conventional design, although undoubtedly a diminution will take place over the years ahead in the proportion of gas made in this type of plant.

The first task, therefore, has been to improve upon present methods of manufacture, which included a programme of integration resulting in the closing down of over 400 small works, and expansion of the larger and more economic units. This, with improvements in plant design, has further increased the efficiency of production, which, measured by the ratio of the thermal output of gas, coke, breeze and tar to the thermal input of coal and oil, reached the high figure of 77.8% in 1956/57. The cumulative effect of this has been a saving of over 10 mill. tons of coal since 1950.

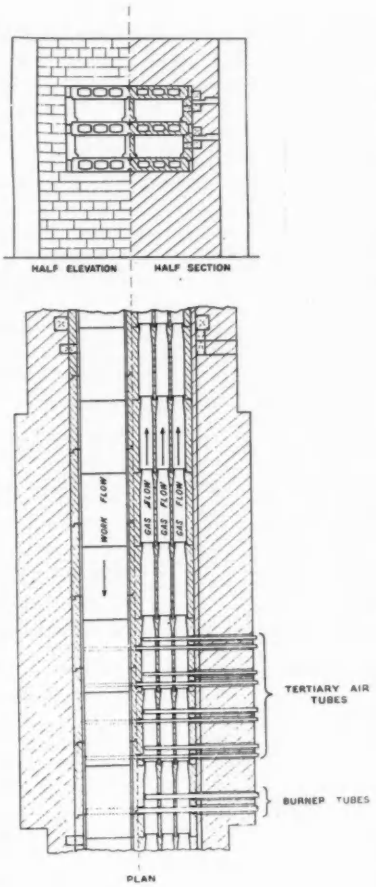


Fig. 11. Prototype multi-passage gas-fired kiln.

At the same time further objectives are being pursued in gasification processes utilising coal not normally suitable for gas making; the development of a process for the hydrogenation of coal and the design of a process based on the Lurgi process, which gasifies coal with oxygen and steam at high pressure.

Promise

The hydrogenation of petroleum oils to produce gaseous hydrocarbons shows considerable promise, and a full scale experimental plant will shortly be in use in the North of England. In addition, a process for gasifying any fraction of petroleum, especially heavy oil, at normal pressures is being put to work on a production scale.

The search for natural gas in Britain, now in its fourth year, would have had a most profound effect upon the economy of the whole country had reasonable success attended the efforts, and although supplies of natural gas are made available to the public for the first time in Great Britain from one of the wellheads in Scotland, the operation as a whole has been disappointing up to the time of writing.

The use of gas from oil refineries,

Fig. 12. A shallow fryer for large scale cooking of sausages and some meats. Capacity approximately 1½ cwt. per hour.

and particularly the possibilities offered by liquefied petroleum and imported natural gases, provide a most hopeful economic prospect. From two refinery projects in the South of England a quantity of tail gases equivalent to the amount of gas produced by 365,000 tons of coal a year will shortly be made available, and more such projects are contemplated.

The use of the liquefied gases, propane and butane, has been practised extensively in the United States for standby purposes, for industrial interruptible supplies, and to a somewhat lesser extent in a number of European countries, but the availability of such gases must eventually be linked to the demand for other fractions of oil.

Comprehensive

The liquefaction of methane has been the subject of a comprehensive survey in Great Britain with the object of importing it in this state, for it reduces to 1/600th of the volume it occupies as a gas, but requires a temperature of −161.5°C. in order to keep it liquid at a low pressure. One ton of liquid methane gives nearly 2½ times the thermal value of the gas, coke and tar from one ton of coal, and nearly twice that of one ton of oil when treated in a gasification plant.

The technical problems of liquefaction, and the transport and storage of gases at such low temperatures, are considerable, but with this must be considered the fact that quantities of gas, far exceeding the current production of the British gas industry, are being lost each day in various parts of the world.

In addition to the problems of constructing suitable ships for the transport of refrigerated methane and vessels for its storage, which now seem largely solved, are those of economics and the increasing dependence upon imported forms of fuel, but as Britain is already taking some 20% of her fuel requirements from abroad, increasing this with such rewarding prospects must be accepted as a reasonable international risk.

Retarded

In Great Britain the demand for refined fuels is increasing but progress is retarded by national economic considerations beyond the control of the secondary fuel industries.

The consumer in Great Britain has a freedom of choice in his selection of fuels, except for certain limits which are placed on the quantity of coal which may be purchased for use in domestic premises. The gas industry is, therefore, supplying gas and coke in competition with solid fuel, oil and electricity. The relative progress in the sales of the different fuels will depend partly upon the prices at which they can be supplied, partly on their convenience in use, and partly on the service which is given by their suppliers. It seems likely that with an increase in the standard of living in the home on the one hand, and a rise in productivity in the factories on the other hand, the consumption of the more refined fuels, gas and electricity will rise at the expense of sales of solid fuel. Any important changeover from solid fuel to gas would lead to a very substantial increase in the present level of gas sales, as can be seen from the following calculations. It can be shown that an increased use of gas and coke in place of solid fuel and electricity would lead to large savings in the use of coal.

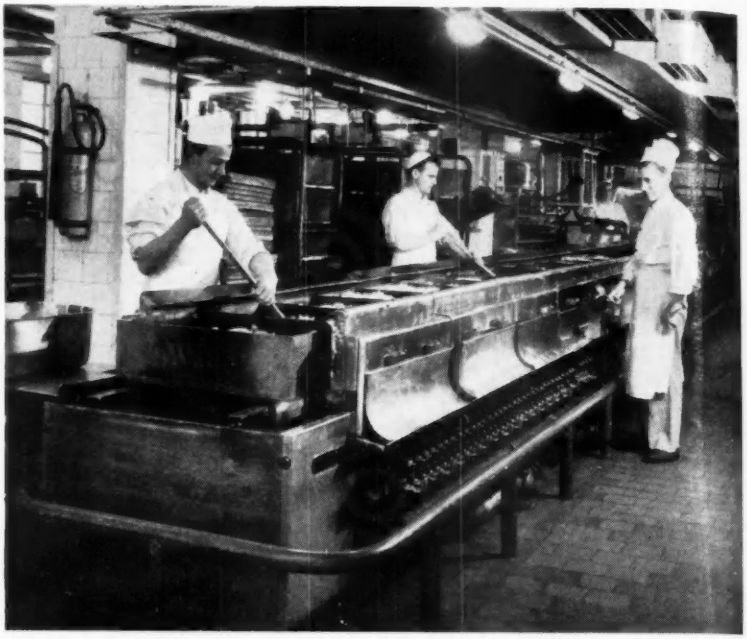


Fig. 13. A continuous unit for cooking vegetables, soups and braised meats. Capacity approximately two tons per hour.

An indication of what might be achieved can be seen from the Gas Council's evidence to the Ridley Committee, in which a possible saving in consumption of coal of 15 mill. tons per annum was shown to result from an increased use of gas and coke in the home.

The present (1956) consumption of fuel in the domestic market is equivalent to 67.0 mill. tons of coal, of which 9.1 mill. tons are provided by gas and 14.5 mill. tons by electricity. If only 10% of the solid fuel now used were replaced by gas, the increased demand would amount to 4.1 mill. tons of coal equivalent, or 615 mill. therms of gas equal to 24% of all gas sold in 1956/57.

In industry (other than iron and steel), the consumption of fuel in 1956 expressed as coal equivalent was 74.3 mill. tons, of which gas provided 4.3 mill. tons, oil 10.1 mill. tons and electricity 18.1 mill. tons. If only 10% of the solid fuel used were replaced by gas, the increase in gas sales would again be 615 mill. therms, equal to 24% of all gas sold in 1956/57.

The fuel price structure for such an expansion programme would depend upon the course of world events, the quantities and proportions of gas available from the various sources and the outcome of an immense amount of research work still going on.

It may be possible with the improved methods of gas manufacture, and the quantities of gas it is hoped to obtain from oil and liquefied methane, to provide a fuel service at a cost no greater than a comparable service with coal for domestic users, and for a large proportion of the commercial and industrial users.

Total Value

It would be impossible to estimate the total value of such a service to the nation as a whole, with its greatly increased efficiency in the utilisation of coal resources, the improved atmospheric conditions, the increased contribution to industrial production and a more stable national fuel situation.

FUEL EFFICIENCY EXHIBITION

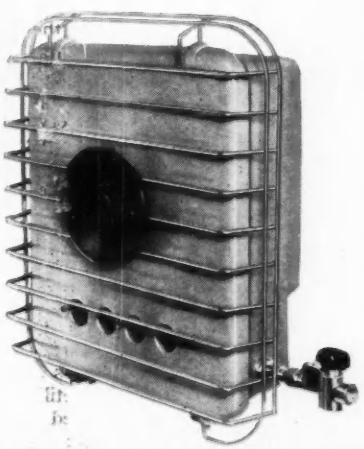
THE Industrial Fuel Efficiency Exhibition, which is open until next Friday, is once again a compact, interesting, and extremely valuable summary of the way manufacturers are taking advantage of the need for modern industry to eliminate unnecessary expense. In fact the theme of the exhibition is 'Greater Productivity at Lower Cost' and the series of lectures arranged covered the economic application of fuel in all its aspects.

Lord Attlee opened the exhibition—the fifth—in which nearly 170 firms are taking part. After paying tribute to the engineering inventiveness of this country Lord Attlee added that he believed the strength of our engineering industry had always been the fact that we had a great number of undertakings and a constant willingness to change.

Slogan and principal theme of part of the **Gas Council's** stand at the Fuel Exhibition is 'Twice the speed and half the cost.'

A large animated panel shows how tank heating can be made faster and cheaper. It contrasts efficient and inefficient methods of insulation, lagging and heating generally, and is supported by pictorial displays showing 'case-histories' of old and new ways of using heat economically. Four large transparencies show industrial installations where gas is used on a large scale and diagrams and photographs depict the use of coke for steam-raising and other industrial processes.

The stand also draws attention to the free technical advisory service provided by the Gas Council and the area boards.



DRUgasar 650, small balanced flue heater, manufactured by F. A. Borchardt Ltd.

Inside view of a water tube boiler being cleaned by a B.V.C. vacuum cleaner.

A new type of coke stoker for firing steam-raising boilers is exhibited. This stoker, manufactured by Joshua Bigwood & Son Ltd., Wolverhampton, has been examined and tested by the Coke Technical Department of the Gas Council and results obtained have been extremely good.

OTHER EXHIBITORS

Allied Ironfounders Ltd., are showing the industrial Spacewarmer which is a free-standing space heater specially designed for heating factories, garages, etc., where ductwork is not desirable. It is a packaged cabinet heater of modern design embodying all the latest developments of heat exchange and automatic control. With a heat output of 250,000 B.t.u. per hour, it is fully automatic in operation with a thermostat and time switch and is particularly useful for installation where intermittent heating is required. Each unit is a complete heating and ventilating system within itself, and is easily transportable. There is also on the stand a range of heavy duty catering equipment.

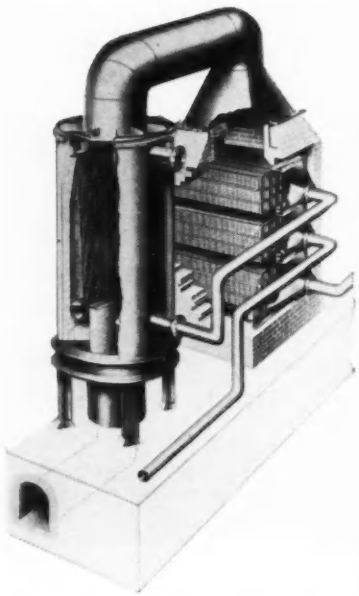
F. A. Borchardt Ltd., is shoying the full range of DRUgasar balanced flue gas space heaters including their newest models. These are the DRUgasar type JBN equipped with magneto ignition and flame failure device, the small DRUgasar 650 which extends the range down to rating of 20 cu.ft. per hour, and the DRUgasar type GW with glowplate ignition and flame failure device. The two latter types are being shown for the first time. The various control valves and flame failure devices are demonstrated, as well as a model illustrating the application of thermostatic control to these heaters.

This type of heater is fitted to a specially constructed flue equipment, so that the heating unit is completely sealed from the room which is being heated and ventilation problems are therefore obviated. The DRUgasar heaters are ideal for warming premises where the heating is intermittent in character, such as offices, churches, church halls, clubs, schools, clinics, waiting rooms, etc. The Arnhem high efficiency solid fuel free standing stove is also being exhibited.

British Rototherm Co., Ltd., are showing a representative selection of instruments with particular emphasis on boiler house and engine requirements and efficient plant operation, comprising dial thermometers (bimetal, mercury-in-steel, and vapour pressure actuated), temperature, pressure and vacuum recorders, temperature controllers, pressure vacuum, compound and altitude gauges.

British Steam Specialists Ltd., are showing a comprehensive range of gunmetal and cast iron flanged and screwed valves. Bourdon-type pressure gauges, bimetallic strip actuated thermometers and the 'Ventalarm' whistling tank filling device.

Among other exhibits on this stand are Vee-Reg valves in bronze and steel in sizes between ¼ in. and 10 in., both screwed and flanged, for use on high and low pressure saturated and superheated steam and high pressure hot water. A comprehensive exhibit of the Velan Monofloat steamtrap is also included. These traps, designed both for high and low pressure steam cover many functions in one unit and



Inka radiant type preheater manufactured by Newton, Chambers & Co., Ltd.

do away with the need for a separate air vent, check valve, strainer, sight glass, temperature indicator and temperature control units. They are made in forged and stainless steel, with hardened ball valves and 'stellite' seatings for pressures up to 2,500 p.s.i.

British Vacuum Cleaner & Engineering Co., Ltd., manufactures a large range of portable industrial cleaners as well as supplying fixed vacuum cleaning installations. They specialise in pneumatic flue cleaning which removes hot ash which has proved capable of maintaining the highest boiler efficiency, and reduces manual labour to a minimum. Extraction, reclamation, or removal of dust, light materials or even liquids can be carried out and a wide range of tools is available to cover most cleaning problems. Tools to meet any special condition can be supplied.

Cape Asbestos Co., Ltd., are showing their products Caposite, Rocksil, and Asbestolux. Caposite moulded asbestos thermal insulation and Rocksil rock wool insulation, as specified and now being fitted to the reactor vessels, heat exchangers, ducting and pipes are displayed. On show also are Caposite blocks and pipe sections favoured by industrial insulating contractors for their great strength, wide temperature range and easily applied single-layer fitting, involving maximum cleanliness on site; and the new inexpensive Rocksil rigid pipe sections particularly suitable for lagging pipes in domestic buildings, office blocks and factories. Asbestolux asbestos insulation board, a roof lining which makes structural insulation the surest and most fire-safe means of saving fuel is also featured on this stand.

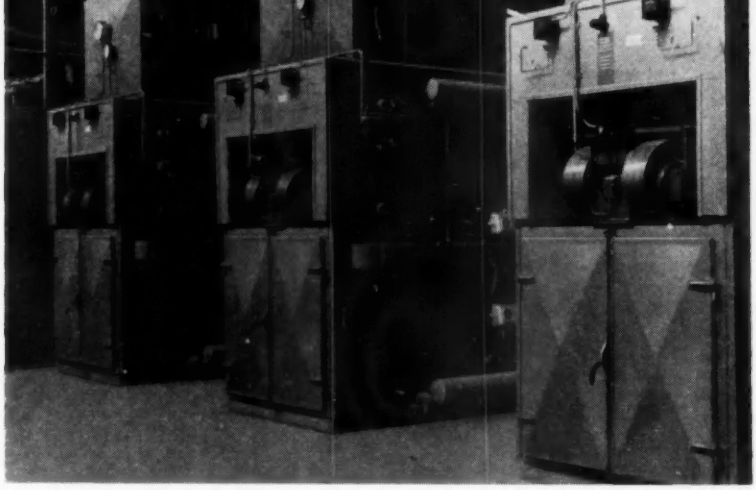
Davey, Paxman & Co., Ltd., have as their main exhibit, an 'S'-type packaged boiler, incorporating the Ultranomic high velocity shell boiler which, together with all its associated equipment, is mounted on a common bedplate. A model of the package 'K'-type water tube boiler is also exhibited. They represent the range of Paxman packaged boilers, supplied steam tested at the works and ready for immediate installation.

The firm's other exhibit is the Paxman rotary vacuum filter as represented by a 10 sq. ft. machine. This unit is also completely packaged with all auxiliaries and is transportable. The function of these filters, manufactured up to 700 sq. ft. in size and in various materials, is to mechanically remove moisture by a continuous operation from industrial slurries so reducing fuel costs in final drying. The filter also recovers the extracted liquor where this is of value.

Derbyshire Silica Firebrick Co., Ltd., show their Dome insulating material, Peaksil 95% silica refractory, used in carbonising, glassmaking, steel and other industries. Thermax, a clay-bonded, siliceous material of high density and low porosity used in gas retorts, and 'Frisil' sillimanite material, employed in the glass industry and high temperature gas-fired furnaces, and muffles. Other exhibits include their DSM-M aluminous, a high alumina refractory used for similar purposes; and DSF siliceous materials, used in re-heating furnaces, checkers and steam boilers and in the carbonising industries.

Elcontrol Ltd., are exhibiting the FSM series (infra-red sensitive) control units for manually-ignited and for fully-automatic gas burners, able to deal with both luminous and non-luminous flames and the FSD series, a special type of photo-electric burner controller suitable for a large number of industrial applications which give fully-automatic ignition programming control as well as running flame failure protection. Other exhibits include a wide range of industrial electronic controllers among which are the liquid level control unit used for controlling boiler levels and readily linked to flame failure equipment to provide shut down when the boiler level reaches an unsafe limit.

Electroflo Meters Co., Ltd., has devoted its stand to the activities of the power generation and industrial boiler plant. A comprehensive display of automatic boiler control equipment and its application to boilers of all types and capacities is the predominant exhibit. The Electroflo-Smoot method of control includes systems pneumatically, hydraulically and electronically operated. Additions to the Electroflo range of pyrometers include fast acting electronic potentiometers



The Redfyre Emma, a coke fired boiler for central heating and hot water supplies in large buildings. Newton, Chambers & Co., Ltd.

for indicating, recording, controlling, or any combination of these, and pneumatic equipment operating at 3-15 p.s.i.

Elliott Bros. (London) Ltd., are showing the company's very extensive range of power-plant instrumentation and control equipment, as well as equipment for heating, ventilating and air-conditioning. Examples are shown of complete installations including indicating, recording and control instruments, panels and cubicles, with emphasis on system design, installation, and commissioning services.

The instruments included cover the measurement of steam and water flow, gas and water temperature, oil and water level, pressure, and draught.

Ether Ltd., is exhibiting a wide range of equipment including the Transitrol range of temperature control instruments, programme controllers, temperature recorders, multi-point indicators, flame failure and ignition controllers.

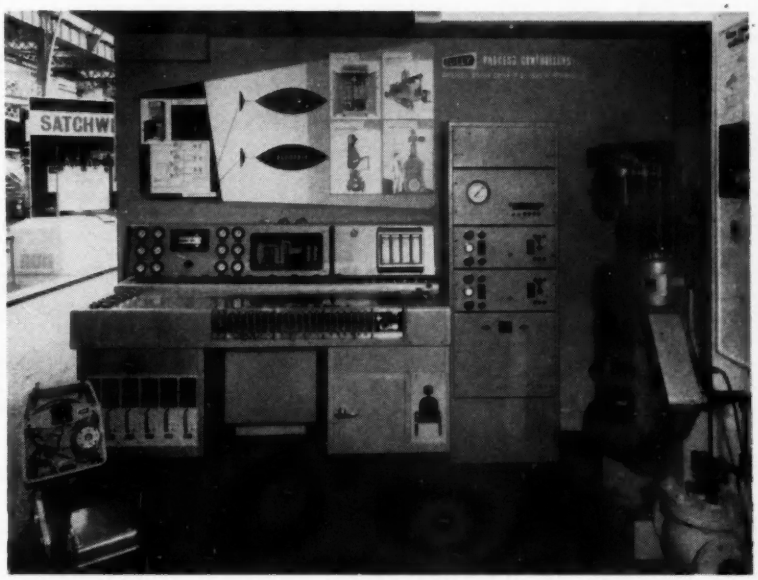
The latest addition to this range is the 995 Proportional Temperature Controller, by which a proportional control over the heating medium—gas, steam, etc—is exercised to eliminate temperature variation once the predetermined set temperature is reached.

Harris Engineering Co., Ltd., is displaying a range of industrial space heating equipment. The gas-fired heaters include Schwank infra-red radiant heaters for wall mounting, or horizontal suspension, unit heaters (flued and unflued), the Wellsway Mark II flued convector heater and cabinet heaters. Air cleaning equipment, also on show, consists of unit dust collectors and Trion electronic air filters, with an efficiency of 99.9% (weight test). The latest addition to the Trion range is a free-standing model which also incorporates the new Harris washable nylon air filter.

W. C. Holmes & Co., Ltd., is exhibiting the Holmes-Schneible multi-wash system which is applicable to a wide range of dust collection and control problems involving liquid and solid particles. An efficiency of the order of 99% for all particles above 3 to 4 microns can be achieved.

The Holmes-Rothemuhle multi-cell cyclone dust collector, designed to reduce stack emissions from hand, stoker and pulverised fuel fired boilers, is also represented.

Also included in the exhibit are the Trion electric air filter, utilising the principle of electrical precipitation, the Holmes-Connervsille positive air blowers, of simple design, having no moving vanes, valves, springs or other small parts to work loose, which, combined with sturdy construction, assures efficient, dependable operation for long periods with a minimum of maintenance. A catalytic sulphur removal plant designed to reduce the content of organic sulphur compounds in town gas, enabling the gas to be applied to processes where substantially sulphur-free atmospheres are necessary, is also to be seen on the stand.



The Tully gasification control console, incorporating electronic timing gear, illuminated flow diagram and valve selector switch gear, designed to operate one of two 2 mill. cu.ft. per day complete gasification plants at Johannesburg.

Hopkinson Ltd., is showing a wide range of valves, boiler mountings and associated equipment. Other exhibits are a motorised Hopkinson-Ferranti valve with control cubicle, full-lift safety valves, several examples of water level indicators, including the televised arrangement, automatic thermal pump leak-off equipment, a selection of forged steel valves, and two types of soot blowers. For low-pressure installations, typical small bronze stop valves, safety valves, reducing valves, pillar water gauge mounting and steam traps are included. A centrifugal separator and a multi-point temperature monitor are also displayed.

Hurseal Group Sales Ltd., is exhibiting a wide and comprehensive range of solid fuel convector open fires, hot-water radiators, and many draughtproofing materials and appliances—all having a wide industrial, commercial and domestic application in the field of fuel efficiency. New equipments on display are hot water convector heaters, the Ripplrad radiator and Skirting radiators for low-level heating.

International Combustion Ltd., is showing as the main feature of this stand a complete corner burner assembly of the type being installed at the Central Electricity Generating Board's High Marnham Power Station. This is one of the corner burners for one of the company's 200-M.W. water-tube boilers. Other exhibits on the stand include a working scale model of an 'L'-type travelling grate stoker.

Keith Blackman Ltd., emphasises in its display the efficient use of air and other gases for industrial purposes. Equipment for fuel efficiency on show includes mechanical draught fans, high pressure blowers, the Cupodel hot-blast cupola plant and a range of industrial gas apparatus. Other exhibits of note are dust and grit collection equipment for meeting the requirements of the Clean Air Act, shot cleaning for heat exchanger tubes and a wide range of axial, centrifugal and propeller fans.

Newton, Chambers & Co. Ltd., are exhibiting a wide range of their equipment in the fuel economy field, including the Redfyre Emma coke-fired boiler, claimed to be the world's most efficient coke-fired boiler, the Inka pre-heater—for air or gas pre-heating up to 850°C., the Struthers Wells heat exchanger—for industrial process heating at elevated temperatures, and the Newton needle tube recuperator unit. Also included are the Redfyre Magazine boiler and needle heat exchange elements for various special applications.

Perl Controls Ltd., are showing models and operating exhibits of various forms of automatic temperature and safety control, including a

range of solenoid valves, ¼ in. to 6 in. B.S.P., of advanced design and incorporating novel features, available for town gas; a variety of thermo-electric flame-protection controls, demonstrating their application to industrial, commercial and domestic gas-fired equipment. Also to be seen are direct and indirect operating immersion thermostats, covering a temperature range from atmospheric up to 1,100°C., and space heating roomstats. A range of relay gas valves and low pressure cut-off valves, from ½ in. to 6 in. B.S.P., are also included.

A recent addition to the company's range is the Juno pilot, shown on the stand controlling one of the working exhibits. This enables the pilot gas supply in addition to the main supply to be controlled in the event of flame failure. The 'bridging-ladder' burner is another recent addition.

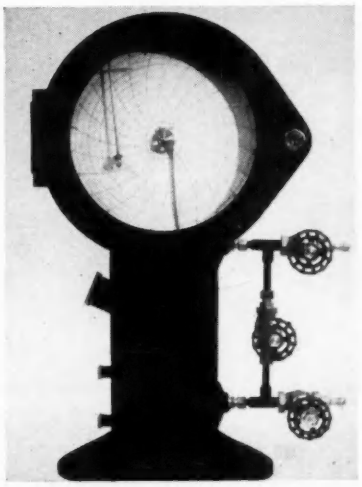
Thomas Potterton Ltd.—the Potterton Division of Thomas De La Rue & Co. Ltd.—is displaying 'Potterton' gas fired boilers suitable for hot water supply and central heating in a wide variety of premises from the small private house to the large office block or factory. A representative selection is shown of Potterton gas-fired boilers available from an output of 30,000 B.t.u. per hour to 1.25 mill. B.t.u. per hour.

Senior Economisers Ltd. are exhibiting as their main item a full-size cast iron 'H' tube economiser in a compact form which can be mounted on an economic boiler without a separate supporting structure. Sections of welded economisers are also on view, together with smaller exhibits to illustrate the main features of design.

Spenser-Bonecourt-Clarkson Ltd., are exhibiting a number of packaged boilers and a model of their waste heat boiler installation. Photographs of several installations are also included on the stand.

Sperryn & Co., Ltd., are showing a comprehensive display of their following products:

These include controlled ignition devices; flame protection controls; industrial thermostatic gas controls; solenoid valves; main cocks and gas fittings; gate, radiator and globe valves, etc. Working exhibition models incorporating gas control devices illustrate the function and uses of these controls, while sectional models show the constructional details. Special attention has been given to the application of G.820 controlled ignition devices to overhead heaters, and the integration of gas and electrical equipment in the G.810 and G.810A flame protection controls. Technicians are in attendance to advise and deal with technical problems.



Arkon portable gas flow recorder Model 58. Walker Crossweller & Co., Ltd.

Teddington Industrial Equipment Ltd., is showing automatic control and protection equipment for heating, ventilating and air conditioning plant, and solid-fuel boilers, including thermostats, pressure switches, humidistats, dial thermometers, level controls, and solenoid valves. Included also are motorised valves, damper motors, furnace draft regulators, burner controls, etc.

There is in addition to be seen on this stand a full range of proportioning control equipment, including the new Teddington electronic control system for air conditioning and heating plants.

Thermic Equipment & Engineering Co., Ltd., are showing, in conjunction with fellow members of their group, a number of different types of burners for a variety of modern fuels.

Tully Engineering Co., Ltd., is exhibiting various automatic control and actuating equipment used by the gas and chemical industries. This type of equipment assists in increasing the overall efficiency of the manufacturing plant and thereby reduces the basic fuel and raw material requirements. The display includes an electro-hydraulic process console, designed to operate a Tully carburetted complete gasification plant. The console includes a process controller with electronic timing gear, plant instruments, illuminated flow diagram and valve selector switchgear. For the purpose of the exhibition the console is arranged to operate various types of electro-servo operated valves which include a flow control butterfly valve, a 4-in. diameter high-pressure steam valve and a 12-in. diameter gate valve. These valves are fitted with various types of remote indicating position indicators and remote indicating signal lamps.

Walker, Crossweller & Co., Ltd., are exhibiting the use of remote reading instruments for gas and air flow, pressure, vacuum, holder height, etc., by the Company's Arkon range of instruments. A working unit shows how up to twelve readings can be sent simultaneously over a single telephone line. Two new instruments are featured; a portable gas flow recorder used with a straight pitot tube and a high differential recorder for the measurement of high-pressure gas, compressed air, steam or water. Included on the Leonard side are displayed Leonard thermostatic mixing valves for steam and water, for hot and cold water, and their application in process and ablution work. This section also includes the Unatap spray mixing-tap.

West's Gas Improvement Co. Ltd.—The Company's display illustrates its engineering and structural work with particular reference to fuel efficiency in gas production, featuring the range of gasworks plant manufactured by members of the West's group. This includes the Glover-West system of continuous carbonisation in vertical retorts, the C.O.L. system of intermittent vertical chambers—both designed for the production of the smokeless fuels, gas and coke.

West's Manchester Ltd., is exhibiting the equipment used in the preparation and handling plant manufactured by the company for coal, coke and other materials. The principal item is a 6 ft. by 15 ft. Flämrich screen designed for the scalping of run-of-mine coal at a northern colliery. Other exhibits include a working model of the unique drum used in the WEMCO dense medium process for the cleaning of large coal, and a laboratory unit demonstrating the operation of WEMCO froth flotation cells for the cleaning of coal slurries.

Wests Piling & Construction Co. Ltd.—The Company's display illustrates West's increment shell piling system, a method which has been extensively used to support foundations for heavy structures of all types, including gasworks, steelworks, airport buildings, factories, bridges, flats and houses. The system successfully combines the principles of pre-cast and cast-in-situ piling and is adaptable to a wide range of site conditions.

Zwicky Ltd., is showing many of its industrial products, and a mock boiler installation. Other products shown include N.Z. dual gauze type filter, Zwikleen self-cleaning filter, pressure regulating and constant pressure control valves and 'V' slot metering valve. The valves are all operating at typical pressures. Also exhibited are filters, hand pumps, nozzles, etc.